TECHNICAL NOTE

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The Forensic Science Use of Reflective Ultraviolet Photography

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ABSTRACT: Reflective ultraviolet photography has many forensic science applications particularly in child abuse, rape, homicide, and bite mark cases. The potential of this relatively simple and inexpensive procedure has not been fully explored. The procedure for its use in bite mark cases is presented.

KEYWORDS: odontology, photography, bite marks, reflective ultraviolet photography, melanin, filter evidence

The mystic of ultraviolet photograpy is unjustified and the products of its use are truly impressive (Figs. 1 through 3). Literature on the subject frequently is very technical and detailed causing a busy forensic technician to set it aside until he has more time. This is unfortunate because with a modest investment of time and money he can obtain significant evidence in child abuse, homicide, late reported rape, and bite mark cases.

Ultraviolet (UV) photography is generally divided into fluorescent and reflective techniques. Fluorescent UV photography records the visible light emissions from subject matter caused by its irradiation with long-wave UV light excluding exposure of the film by UV radiation or incidental light. An example would be photography of a black light entertainment act excluding exposure of the film by the black light itself or other visible light. Reflective UV photography records the reflection and absorption of long-wave UV light by the subject matter excluding exposure of the film by all visible light. This is basically similar to the technique used in latent print black-and-white photography in which you reduce or eliminate a particular colored background through the selective exposure of the film with specific wave lengths of visible light using colored filters. In summary, with fluorescent UV photography we are recording visible light generated by UV irradiation of an object and reflective photography records an object's reflection and absorption of UV light.

Matter absorbs or reflects all light energy wavelengths in varying characteristic amounts.

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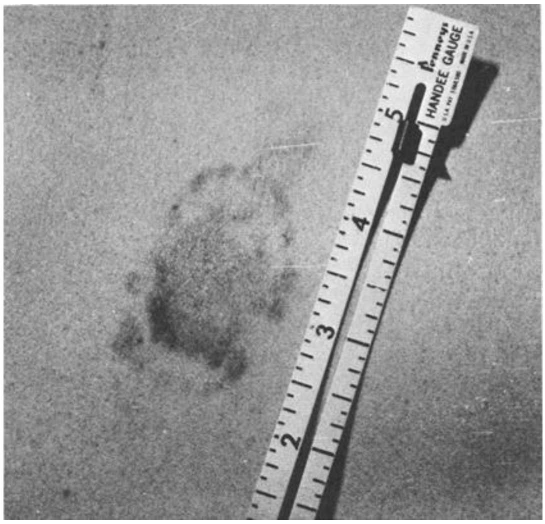

FIG. 1—*Bitemark taken 2 May 1982 with color film ASA 100 with a normal flash.*

In the visible light spectrum objects demonstrate colors because of this. Taking advantage of an object's selective absorption or reflection of long-wave UV light can demonstrate marks, patterns, and other information not normally identifiable. Figure 4 shows a footprint left at a homicide scene recorded using normal visible light photography. Figure 5 shows the same footprint recorded with reflective UV photography yielding much more useful evidence which was subsequently used in court. The use of reflective UV photography has implications in many fields of forensic science investigation in addition to its generally accepted use in questioned documents.

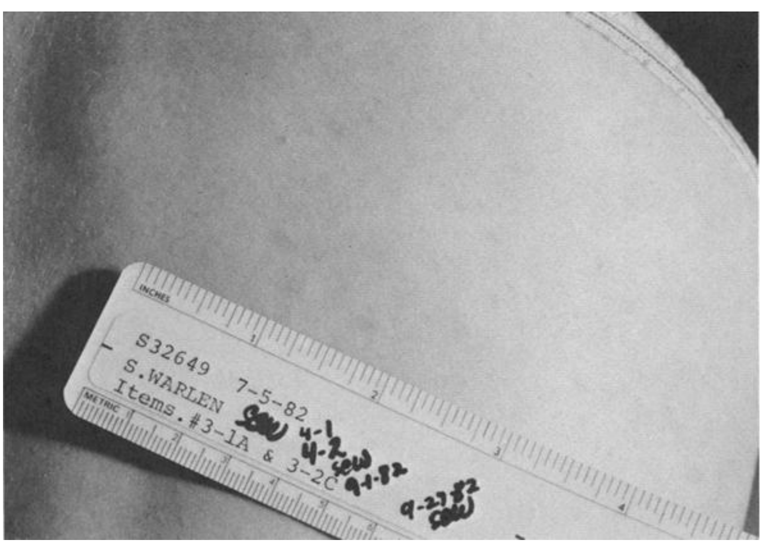

FIG. 2—*Same bitemark as Fig. 1 taken 27 Sept. 1982 with Agfa Vario XL film taken normally.*

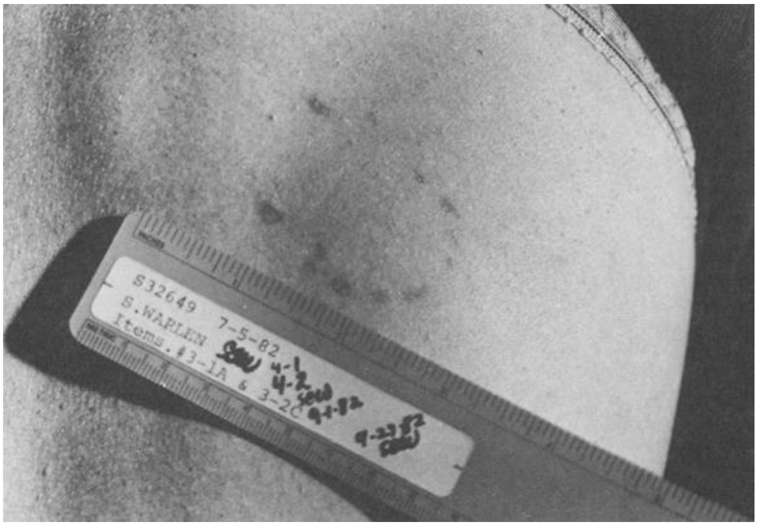

FIG. 3—*Bitemark shown in Figs. 1 and 2 taken 27 Sept. 1982 with Agfa film 3400K lights, 18A filter, F-11 1/15 s.*

Reflective UV photography can have great forensic science value in recording tissue inju patterns found in many types of assaults first suggested by Ruddick in 1974 [*1*] and then b Hempling in 1981 [*2*]. The base layer of human skin normally contains the substance melanin which absorbs UV radiation providing protection from sunburn. The tanning or pigmentation of the skin is associated with the amount of melanin present. Injury to the skin causes melanin to be released spreading throughout the area. With healing, special cells (melaninocytes) gather up to melanin and appear to migrate to the edges of the wound [*2*] providing

FIG. 4—*Footprint left at a homicide scene recorded using normal visible light photography (Ektapan film, F22, 6 s, #47 blue filter).*

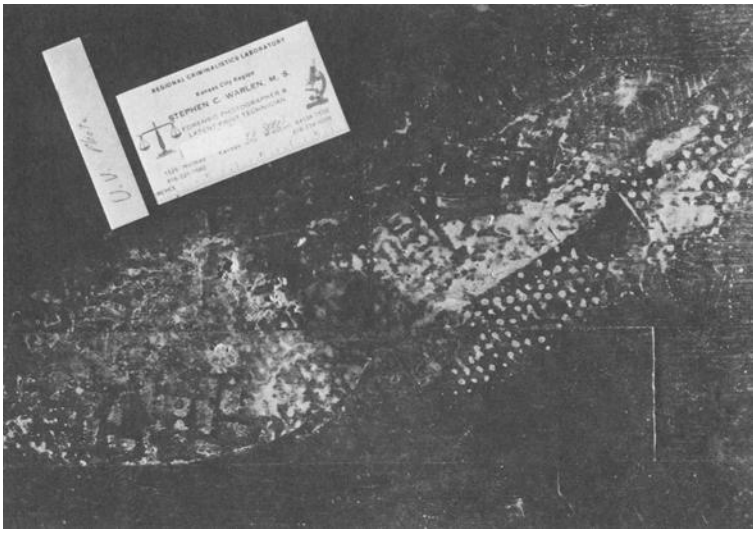

FIG. 5—*Same footprint as Fig. 1 recorded with reflective UV photography (Ektapan film F22, 40 s, OX1 filter, 3400 lights).*

the opportunity to record photographically the outline of the tissue injury pattern. Very simply, with an increase of melanin at the injury site there is more absorption and less reflection of long-wave UV than the surrounding area making possible reflective UV photography (Fig. 6).

The optimum timing of the photography is variable as it depends on rate of healing and the severity of the injury. To the author's knowledge, there are no established guidelines for proper timing of the photography, however, results have been demonstrated as long as five

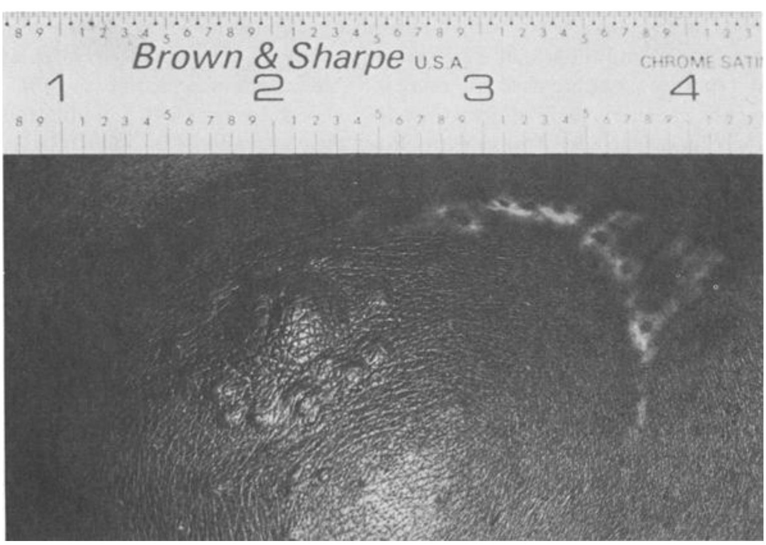

FIG. 6—*Three-week-old bitemark on a relatively light black victim illustrating ultraviolet absorption by the melanin Tri-X film, f-11 flash.*

months after injury. It is unlikely that perimortem injuries can be recorded to advantage using this technique. It appears reasonable that the development of working guidelines is possible.

The equipment required for reflective UV photography is probably already available to the forensic photographer. A camera body with a flash syncronization capable of normal black-and-white work is coupled with a lens of suitable quality for close-up work. Care should be taken to avoid a fluoride coated lens which will absorb UV light. The focal length of the lens is slightly shorter using UV light, however the problem can be avoided in 35-mm photography by not using the larger apertures allowing depth of field to make the compensation [*3*]. Select a black-and-white film sensitive to light in the 300- to 400-nm range such as Kodak® Tri-X, ASA 400. It is not necessary to obtain films with special sensitivity nor is there any advantage in using color films.

To obtain a source of long-wave UV light it is only necessary to calibrate the generation of it coming from the sun, your electronic flash (non-UV filtered models), regular photo floods, fluorescent lamps (regular or black light), or wire filled flash bulbs just to mention a few producers of it. The authors find the electronic flash most suitable for bite mark work where the subject-object distance is not great, the area to be photographed relatively small, the heat associated with other sources objectionable, and a long exposure time undesirable. Since all strobe lights generate varying amounts of long-wave UV light it is a matter of determining the adequacy of a specific flash and calibrating it. The personal preferences of the photographer and the appropriateness to the problem at hand will dictate the source to be used. It is generally possible to develop exposure techniques that allow normal film development and printing procedures.

The only special consideration centers around the use of a filter having a high percentage of transmission of long-wave UV (320 to 400 nm) with a high absorption percentage of all other light wavelengths. To accomplish successfully reflective UV photography, it is essential that only long-wave UV light expose the film! The Kodak® 18A and the Precision Optical OX1[3] are suitable for this purpose. The glass 18A comes in two sizes (13 or 19 cm^2 [2 or 3 $in.^2$]) and requires a filter holder available from Kodak (Gelatin Filter Frame Holder). Precision Optical will mount the OX1 glass filter in a filter ring if you provide it. Because these filters are opaque to visible light, when using a through the lens viewing camera, they must be positioned on the lens after framing and focusing. It is obvious that camera stabilization is necessary, suggesting the use of a tripod and cable release for quality results, especially when long exposure times are used and there is limited depth of field. In many applications, positioning the camera is facilitated by the addition of a side arm with a double action joint head to the tripod. Such an arrangement allows the camera to be positioned lateral to the tripod over or in front of a comfortably positioned victim. Additionally it makes obtaining parallelism between film plane and the object plane easier and more exact. When the side arm is fully extended it is necessary to weight down the tripod base to prevent its tipping over.

To provide some specifics concerning technique, the author's (TCK) step-by-step description for recording a bite mark is presented.

1. A Nikkormat® EL camera with a 55-mm F3.5 Micro NIKKOR lens is loaded with Kodak Tri-X film. The flash syncronization is set for electronic flash and the shutter speed is set for 1/60 s.

2. A Bogen side arm (order number 3059[4]) with a double action ball joint head (order number 3026[4]) is attached to a heavy-duty tripod. A (4.5-kg [10-lb]) lead weight is suspended from the bottom of the tripod (Fig. 7). The ball joint's quick release mount is re-

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[4]Bogen Photo Corp., Lino Manfrotto Co., Italy.

moved and attached to the camera allowing the camera to be attached and removed from the head at will.

3. The sensor of the Vivitar® 283 flash is removed, set on manual, and placed in the receptacle of the remote cord furnished with the flash. This in turn is attached to the hot shoe of the camera and the other end connected to the flash.

4. The victim is comfortably positioned and the camera positioned for proper framing and focus, care taken to have the film plane and the bite mark plane parallel (the object-lens distance generally is (305 to 356 mm [12 to 14 in.]). A high quality rule (Brown & Sharpe 599-314-627) is placed adjacent to the bite mark, a final check of framing and focus made, and the 18A or OX1 filter attached to the lens.

5. The flash is held adjacent to the lens and several exposures made to provide liberal bracketing (f-8 and f-11 probably will be best but shoot f-5.6 through f-32). The flash is then held in different relationships to the bite to further insure achieving optimum results. Care is taken to insure no movement of the victim during the process.

6. The filter is removed and using the same framing several routine black-and-white exposures are made. The camera is then repositioned and some general orientation views are then taken.

7. Following normal film development, the best negatives are selected and printed using normal darkroom procedures.

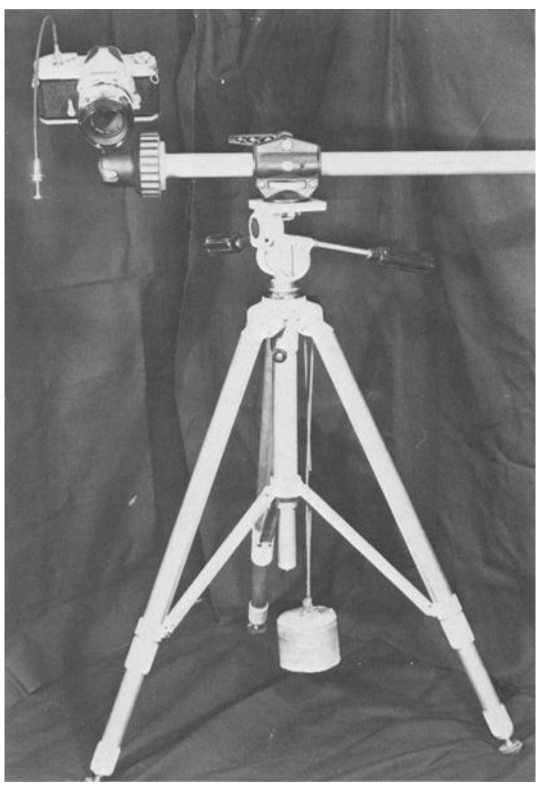

FIG. 7—A *Bogen side arm is attached to a heavy-duty tripod with a 4.5-kg (10-lb) lead weight suspended from the tripod.*

The forensic science application of reflective UV photography has not been fully explored. Workers in the field are suggesting its use to demonstrate tattoo-camouflaged track marks on addicts[5] and the use of a Woods diagnostic lamp (used by dermatologists) to survey child abuse victims to discover old injuries prior to photography [2]. Reflective ultraviolet photograpy will require widespread and varied use to define the limits of its application and assess accurately the appropriateness of its use. It certainly offers the forensic photographer an opportunity to expand his own capabilites as well as those of his profession.

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